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ABSTRACT

Although government social and economic policy, where women and minorities are concerned, is largely focused on income and earnings, specific types of data on the occupational affiliation of women would be useful for research. It is necessary to have a theoretical frame of reference in order to ask the right questions about women's occupational affiliation. Very little is known about the technological conditions governing the formation of skills on the job, and much more needs to be known about occupational choice and mobility. As a step toward asking the right questions, a simple framework has been developed which links together occupational affiliation, human capital formation, and wage rates. It affords a means of discussing both theoretical and empirical issues that relate to the occupational attachments of women. Data limitations can be found at both the macroeconomic and microeconomic levels of analysis. For the purposes of understanding and predicting changes in occupational distribution among women, annual data on detailed occupational distributions must be made available. Similarly, detailed occupational data should be made available on a more frequent basis for local labor markets. Public policy aimed at enhancing the occupational opportunities for women cannot be made fully operational merely on the basis of economy wide statistics, nor can individuals really respond effectively to information of U.S. wide averages. Finally, comprehension of how individuals choose occupations and subsequently form marketable skills depends upon the availability of longitudinal data on individual households. (A detailed presentation of the conceptual framework for discussing the relationship between occupation, skill formation, and wage rates, is included.) (JT)

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ON THE USE OF OCCUPATIONAL STATISTICS

Census Bureau Conference on Issues

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April 27-28, 1978

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ON THE USE OF OCCUPATIONAL STATISTICS

Social and economic policy iniatives on the part of government are presumably inspired by a collective interest in the well being of certain identifiable groups in society. While there is no unique measure of the well being of households or individuals, income seems to be everyone's favorite proxy. Where women and minorities are concerned, government policy is largely concerned with income derived from labor market earnings. In view of the abundant data available on income and earnings, and the policy importance attached to household incomes, what role can data on occupational affiliation play in the formation of public policy? It is the purpose of this paper to describe the types of data that would be useful for research on the occupational affiliation of women. Part I below is an introduction, Part II is a conceptual framework for discussing the relationship between occupation, skill formation, and wage rates, Part III is a discussion of data needs, and Part IV is a summary and conclusion.

I. Introduction

Logically prior to a discussion of occupational data needs is some explicit or implicit theoretical framework of the role of occupation in earnings formation. One has to have some idea of what questions to ask before a decision can be made about what types of data ought to be collected and disseminated. At the most fundamental level we have to decide what constitutes an occupation. There are any number of ways to assign occupational codes and titles. Presumably, the purpose of occupational codes is to convey something about what people do in their jobs. Occupational titles also convey information about wages and socioeconomic status of individuals.

In a study by Welch and Maclennan [1976], it was found that 98% of the wage variance captured by 298 census occupational titles could be explained by condensation of the titles into nine broad categories. As these authors point out, efficiency dictates that for a given number of occupational titles the maximum amount of information be conveyed, or for a given amount of information the least number of titles should be used. It is not the purpose of this paper to suggest more appropriate occupational classification schemes; however, I will argue below that within the current system of occupational titles adopted by the Bureau of the Census, data at the three digit level are necessary to study occupational mobility.

Because it is the vehicle by which the returns to human capital investment are realized, occupational affiliation is central to the human capital investment process. Indeed, occupation is a major means by which investment is possible. Apart from mandatory general education, a human capital investment decision is tantamount to selection of an occupational goal. In fact it is the association of occupations with reasonably well defined preparatory requirements and earnings opportunities that provides the individual with the information necessary to make investment decisions (occupational choices). These decisions are conditional upon the individual's preferences, aptitudes, and resources.

II. Conceptual Framework

A person's earnings capacity can be expressed as the product of his or her embodied human capital times the market rental rate per unit of human capital. Apart from innate ability, embodied human capital is acquired as a result of an investment process undertaken by the individual. In general the optimal human capital investment to be undertaken each year

is determined by the solution to a lifetime utility maximization problem in which one faces various resource and technological constraints. Human capital augmenting investments are usually dichotomized into schooling and post schooling investments. The latter consists largely of on-the-job training (OJT).

In addition to human capital investments that raise earnings by increasing one's stock of human capital, there are investments that increase earnings by raising the market rental rate applicable to one's existing stock of human capital. The most familiar example is that of migration. Presumably, migration in and of itself has no effect or at most negligible effect on one's human capital stock; however, one's current stock may be more highly valued elsewhere. Similarly, worker mobility between firms in the same labor market can also be viewed as an investment directed toward moving the services of one's human capital stock to where they are more highly valued. Job search theory is another manifestation of an investment process whereby workers seek the highest remuneration to their existing human capital stock subject to the appropriate resource constraints.

Although for some analytical purposes it may be appropriate to lump all human capital together, in actuality embodied human capital is not a homogeneous entity. One's embodied human capital can be thought of as a vector of skills, traits, innate abilities, etc. Each element of the vector is associated with a given market rental value per unit of the skill. The vector of market rental values varies across occupations.[1] Thus different skills and traits in a given occupation are associated with different market rewards. Also, a given skill or ability is associated with different market returns across occupations. In this hedonic approach,

it is assumed that the market rental rates for various skills are determined by demand and supply conditions separately for each occupation.

In addition to variation in market rental rates, occupations can be characterized by variation in their minimum and maximum skill requirements. Each occupation specifies minimum skill requirements that a prospective worker must satisfy as a necessary condition for employment. Each occupation can also be distinguished by the maximum levels of various skills beyond which no additional pecuniary award is earned. At any point in time one's potential wage in a particular occupation can be expressed as

$$w_t^0 = \beta_t^{0'} \tilde{K}_t^0 \quad \text{when } K_t^{\min 0} \leq K_t \qquad (1)$$

$$= 0 \qquad \text{otherwise}$$

where

$\beta_t^{0'}$ is a $1xN_k$ vector of market rental rates appropriate to each skill in occupation 0 at time t,

$\tilde{K}_t^0$ is a $N_k x1$ vector of an individual's compensable skills in occupation 0,

K_t is a $N_k x1$ vector of the individual's entire skills,

$K_t^{\min 0}$ is a $N_k x1$ vector of minimum skills required for employment in occupation 0 at time t,

$K_t^{\min 0} \leq K_t$ if and only if $K_{it}^{\min 0} \leq K_{it}$ $\forall$ i, $K_{it}^{\min 0} \in K_t^{\min 0}$, $K_{it} \in K_t$, and

$\tilde{K}_{it}^0 \in \tilde{K}_t^0$ such that

$\tilde{K}_{it}^0 = K_{it}$ for $K_{it}^{\min 0} \leq K_{it} \leq K_{it}^{\max 0}$ where $K_{it}^{\max 0}$ is the maximum level of skill i that is compensable in occupation 0, and $\tilde{K}_{it}^0 = K_{it}^{\max 0}$ for $K_{it} > K_{it}^{\max 0}$ $\forall$ i.

For some occupations it may be necessary to modify the notion of maximum compensable levels of skills. For example, in some occupations there may be no theoretical upper limit to the amount of any relevant skill that is rewarded. In practice, however, individuals do not receive infinite wages. Resource constraints put an upper limit on the quantity of skills that can be provided to the market by an individual. One who is in possession of a scarce talent may be highly rewarded in the market, but this is the effect of supply and demand forces on the market rental rates of skills rather than the absence of a maximum compensable level of skills. Thus it should do no great violence to the facts to assume an upper limit on each skill beyond which additional levels of skill add nothing to the individual's wage.

In order to better illustrate the uses of the framework set out by expression (1), let us consider the simple case of an occupation which utilizes only two skills. For notational convenience the time subscript is dropped. Each of the wage isoquants (selected from an infinite number of isoquants) in Figure 1 depicts differing combinations of skill levels which yield a given wage at fixed market rental rates, i.e., $dw^0 = 0$. As we move out in a generally northeasterly direction along the wage isoquant map we encounter isoquants that depict combinations of skill levels representing successively higher wage levels up to some maximum. The lowest wage paid in the occupation is represented by the wage isoquant that consists of the single point $(K_1^{\min 0}, K_2^{\min 0})$. On the other hand, the maximum attainable wage is represented by an isoquant that is actually a region defined by the set $S^{\max}$:

$$S^{max} = \{(K_1, K_2) | K_1^{max\ 0} \leq K_1 \text{ and } K_2^{max\ 0} \leq K_2\}. \tag{2}$$

The region is bordered by a Leontief type relationship whose corner is $(K_1^{max\ 0}, K_2^{max\ 0})$. Thus the maximum attainable wage is associated with all pairs of skill levels in which the skill in each category exceeds the maximum skill level for which additional market returns can be earned. In Figure 1 the slopes of all wage isoquants intermediate between the minimum and the maximum wage are given by

$$\begin{aligned} dK_2/dK_1 &= -\beta_1^0/\beta_2^0 \quad \text{for } K_1^{min\ 0} < K_1 < K_1^{max\ 0} \text{ and} \\ & \qquad K_2^{min\ 0} < K_2 < K_2^{max\ 0} \\ &= 0 \quad \text{for } K_1^{max\ 0} \leq K_1 \text{ and } K_2^{min\ 0} < K_2 < K_2^{max\ 0} \\ &= \infty \text{ for } K_1^{min\ 0} < K_1 < K_1^{max\ 0} \text{ and } K_2^{max\ 0} \leq K_2. \end{aligned} \tag{3}$$

Figure 2 depicts the relationship between the potential wage in an occupation and the amount possessed of a particular skill holding constant the level of other skills. Again it is assumed that there are only two skills involved and that the market rental rates are fixed. Expression (1) evaluated at $(K_1^{min\ 0}, K_2^{min\ 0})$ and $(K_1^{max\ 0}, K_2^{max\ 0})$ corresponds in Figure 2 to $w^{min\ 0}$ and $w^{max\ 0}$, respectively. The slopes of the wage/skill (K_1) profiles in Figure 2 are given by:

$$\begin{aligned} \partial w^0/\partial K_1 &= \beta_1^0 \quad \text{for } K_1^{min\ 0} < K_1 < K_1^{max\ 0} \text{ and } K_2^{min\ 0} \leq K_2 \\ &= 0 \quad \text{for } K_1^{max\ 0} \leq K_1 \text{ and } K_2^{min\ 0} \leq K_2 \end{aligned} \tag{4}$$

Therefore, for a given value of K_2 greater than or equal to $K_2^{min\ 0}$, the wage will rise along a particular wage/skill profile for increases in

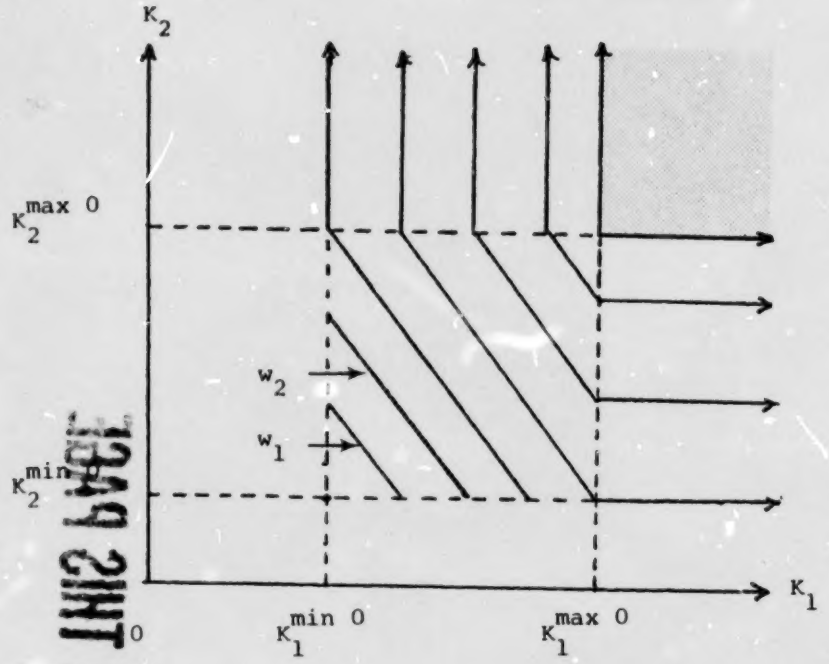

Figure 1

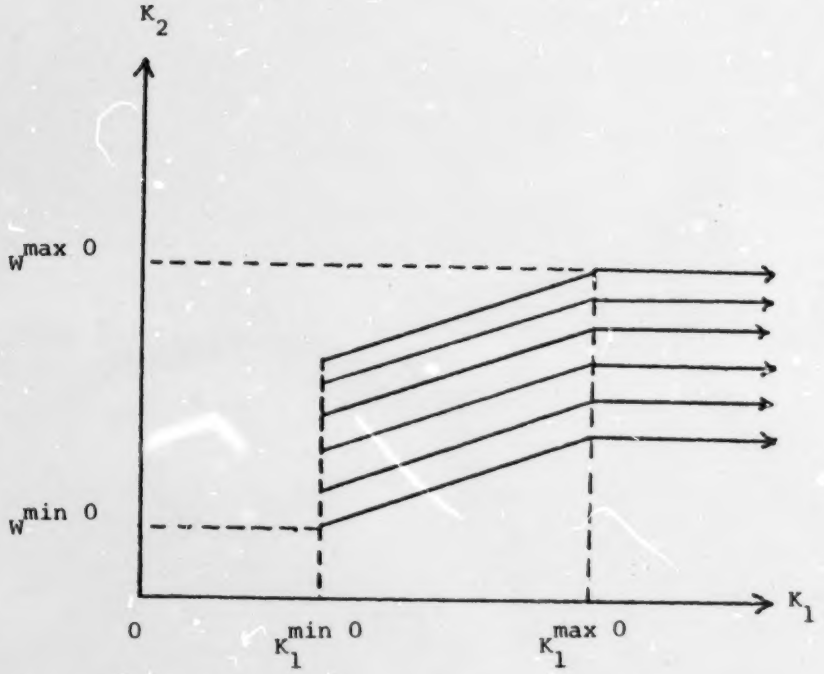

Figure 2

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K_1 above $K_1^{min\ 0}$. Also for a given value of K_1 greater than or equal to $K_1^{min\ 0}$, increases in K_2 between $K_2^{min\ 0}$ and $K_2^{max\ 0}$ will raise the wage as one moves to successively higher wage/skill profiles.

An interesting application of the above framework concerns the differential effects of a legislated minimum wage on various occupations. In the presence of a minimum wage law the lowest attainable wage in an occupation cannot fall below the legal minimum. In occupations in which the legal minimum wage is binding, minimum skill requirements can simply be raised in order to render the value of a set of minimally required skills equal to the legal minimum wage. Expression (1) can be easily modified to reflect conformance of the minimum skill requirement with legaily mandated minimum wages. Increases in the minimum wage can thus lead to unemployment of those whose skills no longer satisfy the new standards. Consequently, one can expec: the employment effects of minimum wages to vary substantially across occupations. Also to the extent that the occupational distribution differs between men and women, the effects of the minimum wage may be different for men and women.

Possible unemployment effects can be easily demonstrated with the simple two skill example introduced above. Imposition of a legal minimum wage that exceeds an occupation wage when expression (1) is evaluated at $(K_1^{min\ 0}, K_2^{min\ 0})$ changes the minimum skill requirement of the occupation. The minimum skill requirements would now have to be satisfied by any combination of K_1 and K_2 that lies on the wage isoquant corresponding to the legislated minimum wage. Consequently, all those individuals whose skill bundles fall below the legal minimum wage isoquant are rendered unqualified for employment in the occupation. This outcome is depicted in Figures 3 and 4 for the wage isoquant map and the wage/skill profiles, respectively.

In Figures 3 and 4 w^m denotes the legal minimum wage. The minimum skill requirements are changed by the legal minimum wage from $(K_1^{\min 0}, K_2^{\min 0})$ to

$$S^{\min} = \{(K_1, K_2) | w^m = \beta_1^0 K_1 + \beta_2^0 K_2, K_1^{\min 0} \leq K_1 \text{ and } K_2^{\min 0} \leq K_2\}. \tag{5}$$

If $K_2 = K_2^{\min 0}$ then minimum qualifications require $K_1' \leq K_1$ where

$$K_1' = (w^m - \beta_2^0 K_2^{\min 0})/\beta_1^0 \tag{6'}$$

Similarly if $K_1 = K_1^{\min 0}$ then minimum qualifications require $K_2' \leq K_2$ where

$$K_2' = (w^m - \beta_1^0 K_1^{\min 0})/\beta_2^0.^2 \tag{6"}$$

Another potential area of application for the conceptual framework introduced in this paper is the secondary labor market of dual labor market theory. Jobs in the secondary labor market are characterized as low paying and relatively insensitive to additional skill and effort on the part of the worker.[3] These jobs are regarded as dead end jobs, and women and minorities are overrepresented in them. No real social problem is raised by those who are employed in these jobs for only a brief transitory phase of their working lives, e.g., college student dishwashers. Social issues are raised, however, when women and ethnic minorities exhibit a disproportionately larger share of the permanent attachments to the occupations in which these jobs are mainly clustered. The precise separation between primary and secondary jobs is arbitrary, but it does involve comparisons between occupations of maximum attainable wages and maximum compensable levels of skills.

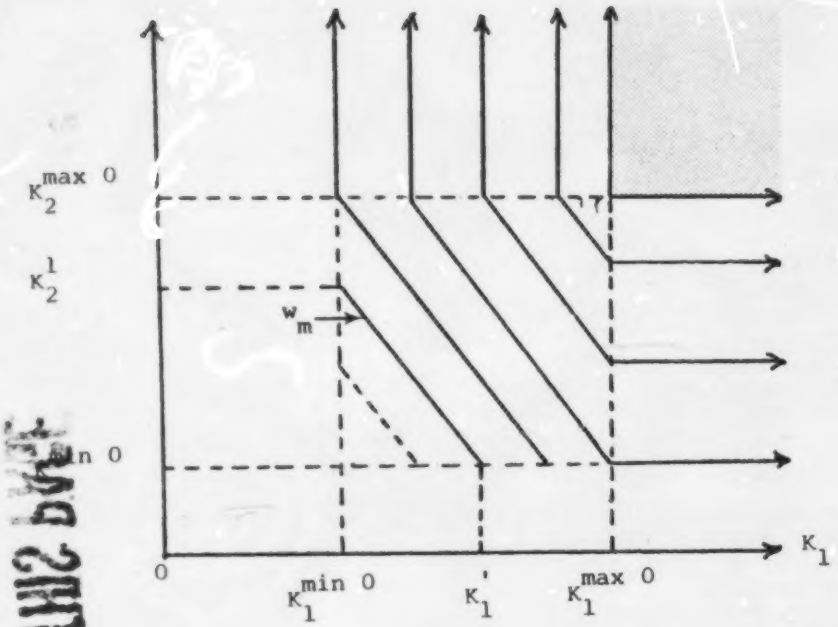

Figure 3

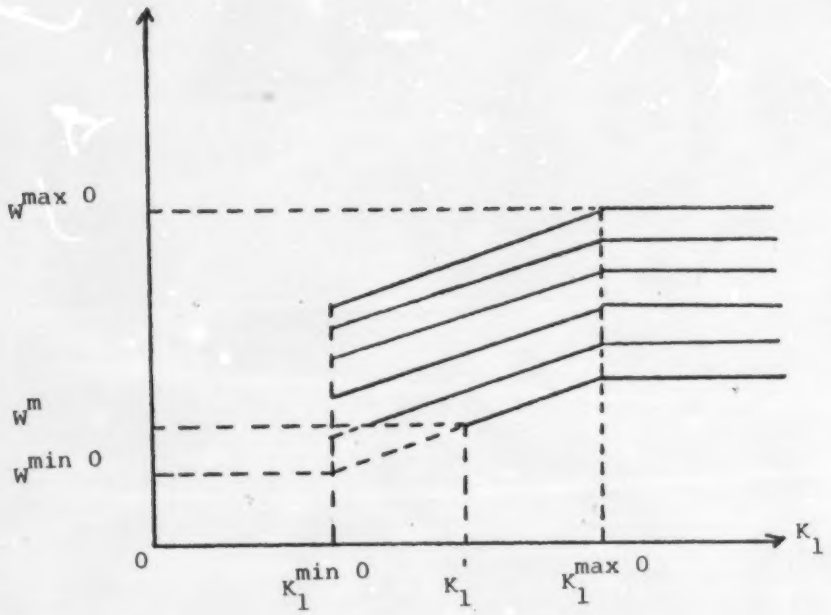

Figure 4

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Within the conceptual framework adopted in this paper, the investment outlay required of an individual to attain any desired wage level in any particular occupation is determined by the production function relationships governing the production of the elements of K_t. The individual combines his or her own time with other inputs to produce various forms of human capital. Each type of human capital is subject to a depreciation rate which can vary over time. The net change in one's vector of human capital characteristics can be described by

$$\Delta K_t = Q_t - D_t K_t \tag{7}$$

where

Q_t is a $N_k x 1$ vector of gross additions to human capital with a typical element Q_{it};

D_t is an $N_k x N_k$ matrix of human capital depreciation rates with diagonal elements δ_{it} and 0 values for all off diagonal elements;

K_t is our $N_k x 1$ vector of human capital characteristics; and

ΔK_t is a $N_k x 1$ vector of net changes in human capital whose typical element is ΔK_{it} where $\Delta K_{it} = Q_{it} - \delta_{it} K_{it}$.

It is customary to view formal education as a period of complete specialization in general human capital formation. All of the individual's available time is assumed to be allocated to the production of general skills during this phase of the life cycle. However, it is reasonable to suppose that the degree of generalization diminishes at successively higher levels of education. One's education, if pursued beyond the legal minimum level implied by the various state laws mandating education up to a specified age, becomes increasingly specific to either a single occupation or cluster of occupations. After completion of the formal schooling phase, an individual's investment in human capital largely consists of OJT.

For analytical convenience, it is customary to treat post schooling investment activity as separable from earning a living. That is to say, one can choose his or her allocation of time between OJT and earnings. The costs of OJT are the foregone earnings plus any direct costs. However, it is not difficult to imagine that some joint production takes place in which human capital formation automatically accompanies production for earnings. In the extreme case in which all post schooling human capital formation is characterized by joint production with earnings, once one opts for a given occupation, his or her wages in the occupation will rise up to some maximum with increases in the skill vector attendant upon the normal work routine. It would not be possible, for a given number of hours engaged in nonmarket time, to raise earnings by devoting more work time to earning and less to OJT.

Once an individual has completed formal schooling, generally the most efficient way to acquire occupation specific human capital is to be employed in the desired occupation. The case in which one can produce human capital on the job depends on one's abilities and aptitudes as well as occupational specific technological conditions governing human capital formation on the job. Over a wide age range we should expect to observe less occupational mobility as one grows older. As a worker's skill mix is increasingly specialized toward maximizing his or her earnings in a particular occupation, the larger the reduction in the wage that would be experienced if the skill vector were evaluated according to the wage structure of any feasible alternative occupation. This wage reduction must be balanced against any future benefits to be derived from occupational mobility. With any positive rate of discount, the present value of the net return from a change in occupation will fall the shorter the remaining period over which

returns can be collected. This is reinforced if a worker must divert time away from earning on the new job in order to invest in those skills important in the alternative occupation.

We are now in a position to evaluate discrete changes in a worker's wage rate. The general expression for a wage change is

$$\Delta w_t = \Delta \beta_t' \tilde{K}^0_{t-1} + \beta^{0\prime}_{t-1} \Delta \tilde{K}_t + \Delta \beta_t' \Delta \tilde{K}_t \qquad (8)$$

where

$\Delta \beta_t'$ is a $1 \times N_k$ vector of changes in market rental rates, and $\Delta \tilde{K}_t$ is a $N_k \times 1$ vector of changes in human capital characteristics.

Consider first a change in the market rental rates for a given occupation without any change in an individual's human capital. The change in market rental rates could occur in one's current labor market or result from a move to another labor market. Under either of these circumstances we can express the resulting wage change as

$$\Delta w^0_t = \Delta \beta^{0\prime}_t \tilde{K}^0_{t-1} \qquad (9)$$

where

$\Delta w^0_t = w^0_t - w^0_{t-1}$, and
$\Delta \beta^{0\prime}_t = \beta^0_t - \beta^0_{t-1}$

If the change in market rental rates is due to a change in occupation, which may or may not involve geographic migration, the terms in (8) have the following interpretation:

$\Delta w_t = w^1_t - w^0_{t-1}$,
$\Delta \beta_t' = \beta^{1\prime}_t - \beta^{0\prime}_{t-1}$, and
$\Delta \tilde{K}_t = \tilde{K}^1_t - \tilde{K}^0_{t-1}$.

In the event that the change in occupational affiliation does not involve changes in maximum compensable skill levels, or if such changes do not affect the individual, $\Delta\tilde{K}_t = 0$ and expression (8) simplifies to

$$\Delta w_t = \Delta\beta_t' \tilde{K}^0_{t-1} \tag{10}$$

Finally, we consider the effects of changes in human capital characteristics on the individual's wage in a particular occupation. The change in the wage may now be expressed as

$$\Delta w^0_t = \beta^{0'}_{t-1} \Delta\tilde{K}^0_t \tag{11}$$

where

$$\Delta\tilde{K}^0_t = \tilde{K}^0_t - \tilde{K}^0_{t-1}$$

Apart from changes in maximum compensable skill levels, the change in the wage will be attributable to the influence of net investment in human capital. For any given human capital component, as long as the gross production of that form of human capital exceeds the amount lost through depreciation, net investment will be positive.[4] As long as one has not reached a maximum compensable skill level, positive net investment for any component of human capital will contribute to the individual's wage growth. We would expect that as one grows older, wage growth would diminish. The effects of depreciation coupled with a finite time horizon over which to collect the returns from further investment yield successively smaller net investments.

In general the proportionate wage change can be expressed as

$$\Delta w_t / w_t = \gamma^{0'}_{t-1} \Delta Z_t \tag{12}$$

where

$\gamma^{0'}_{t-1}$ is a $1xN_k$ vector whose typical element is

$$\gamma^{0}_{it-1} = (\beta^{0}_{it-1}\,\tilde{K}^{0}_{it-1})/w^{0}_{t-1}, \text{ and } \sum_i \gamma_{it-1} = 1, \text{ and}$$

ΔZ_t is a $N_k x1$ vector whose typical element is

$$\Delta Z_{it} = (\Delta\beta_{it}/\beta^{0}_{it-1}) + (\Delta\tilde{K}_{it}/\tilde{K}^{0}_{it-1}) + (\Delta\beta_{it}/\beta^{0}_{it-1})(\Delta\tilde{K}_{it}/\tilde{K}^{0}_{it-1}). \quad (5)$$

Thus the proportionate wage change is a weighted average of the proportionate changes in market rental rates, human capital characteristics, and the product of proportionate changes in rental rates and human capital. The weights correspond to each human capital component's proportionate contribution to the wage in the base period. Depending on the source of the wage change, some of the proportionate changes in ΔZ_t may be set equal to zero.

From the construction of the proportionate wage change in (12) it is clear that a person's actual wage path and potential wage paths over time are going to be somewhat erratic. This is in contrast to the usual impression of a smooth, concave, wage/experience profile derived from highly simplified models of human capital formation. The reason for this is that we are considering more varied sources of wage changes. Changes in net investment in a homogeneous stock of human capital give way to changes in net investment in a vector of human capital attributes. Furthermore, we are considering changes in market rental rates due to occupational mobility, structural changes in occupations, and to autonomous growth in productivity. Consequently while the wage path may be concave, it need not turn down after reaching a peak. To take a simple illustrative example, suppose autonomous growth in productivity raises the market rental rates by a constant proportion, i.e., $\Delta\beta^{0}_{it}/\beta^{0}_{it-1} = g > 0, \forall\ i$. For an individual in a given occupation, it can be shown that the proportionate wage growth is

$$\Delta w^{0}_{t}/w^{0}_{t-1} = g + (1 + g)\ \gamma^{0'}_{t-1}\ \Delta\tilde{z}^{0}_{t}$$

where

$\Delta\tilde{z}^{0}_{t}$ is a N_kx1 vector whose typical element is $\Delta\tilde{z}^{0}_{it-1} = \Delta\tilde{K}^{0}_{it}/\tilde{K}^{0}_{it-1}$

Thus we can say that

$$\Delta w^{0}_{t}/w^{0}_{t-1} \gtreqless 0 \text{ as } g/(1+g) \gtreqless -\gamma^{o'}_{t-1}\ \Delta\tilde{z}^{0}_{t}.$$

Accordingly, one's wage could be maintained even if average net investment were negative so long as autonomous productivity growth were just sufficient to offset the weighted average of net investments. The proportionate change in the real wage is obtained by subtracting the proportionate change in the price level from each side of equations (12) and (13).

In a labor market characterized by downward money wage rigidity, occupational mobility may be a means of facilitating downward wage adjustments. Suppose the weighted average net investment rate of a worker were negative and greater in absolute value than the autonomous productivity rate of growth. Such circumstances would indicate a fall in an individual's money wage. In the presence of institutional arrangements which inhibit an employer from lowering the money wage of an employee in his or her current job, various alternatives suggest themselves. First of all, rising demand for the firm's product may allow sufficient growth in the price of the firm's output to bring about the desired reduction in the employee's real wage to the firm. Secondly, an employee could be moved to another job within the firm, and thereby come under another wage structure. Thirdly, the employee could be forced to quit or be fired. In this instance the individual may either leave the labor force, which can be viewed as an occupational change, or seek employment in another occupation. If a worker

is forced by circumstances to resort to occupational mobility and wishes to avoid frequent changes in employment, he or she would tend to opt for feasible occupational alternatives in which skill depreciation is relatively unimportant. Such would be the case in an occupation in which the important components of human capital depreciate very slowly or in which the maximum compensable skills are well below the individual's current skills. In the latter instance, depreciation of an individual's human capital would have no effect on the wage so long as the person is on the horizontal segments of the wage/skill profiles depicted in Figure 2.

Downward money wage rigidity can be an important factor when firms in a labor market experience a decline in the demand for their output. To the extent that a reduction in market rental rates would have cushioned the employment decline, downward money wage rigidity will lead to greater employment declines. These employment reductions can entail cutbacks in the work week and/or in personnel. To varying extents, the future wages of those experiencing a reduction in employment will be adversely affected. The reduced work week means less net investment and a layoff can mean negative net investment. Consequently, a worker's human capital is not as great when full employment resumes as it would be if he or she remained fully employed at a temporarily lower wage. Hence the wage rate after the resumption of full employment is smaller than it would otherwise have been. An individual unemployed or out of the labor force for a lengthy period can experience a considerable amount of skill depreciation.

Casual empiricism suggests that the longer an individual remains unemployed the lower the probability that he or she will find employment. The idea is that the depreciation of human capital renders an individual less employable. In our framework this means that the probability of finding

a job in the vicinity of one's previous wage is lower, especially in one's previous occupation. Also, as an unemployed worker's skills depreciate, the number of jobs in which a worker's vector of skills meet the minimal requirements is reduced. The remaining feasible occupational alternatives may be so unattractive that the unemployed worker leaves the labor force. This scenario is quite applicable to structural unemployment. The policy prescription has been to facilitate geographic and/or occupational mobility. In the case of desired occupational mobility, job training programs are the usual recommendation. Upon completion of job training instruction, immediate placement is imperative, otherwise the worker is likely to find him or herself in the same set of circumstances that prevailed prior to the instructional period.

Thus far little has been said about occupational earnings as opposed to wage rates. I have assumed a fixed number of annual hours of work so that any change in earnings was solely the result of a change in the hourly wage. A completely general approach would treat lifetime consumption, leisure, human capital investment, and desired hours of market work as endogenous. The identities describing occupational earnings, absolute change in earnings, and proportionate change in earnings are given below by (14), (15), and (16), respectively.

$$Y_t^0 = w_t^0 h_t \tag{14}$$

$$\Delta Y_t = h_{t-1} \Delta w_t + w_{t-1}^0 \Delta h_t + \Delta w_t \Delta h_t \tag{15}$$

$$\Delta Y_t / Y_{t-1}^0 = \Delta w_t / w_{t-1}^0 + \Delta h_t / h_{t-1} + (\Delta w_t / w_{t-1}^0)(\Delta h_t / h_{t-1}) \tag{16}$$

where

Y_t^0 = annual earnings in occupation 0 in year t,

h_t = annual hours worked in year t,

ΔY_t = change in earnings, and

Δn_t = change in hours worked.

If in the latter phase of the work life individuals value leisure very highly, the reduction in time allocated to OJT may be insufficient to accommodate a rising demand for leisure. The consequence would be that hours of work would fall.[6] If the absolute value of the proportionate reduction in labor supply just equals and then surpasses proportionate increments in the wage rate, observed earnings will peak and then decline.

III. Data Needs

Now that the formal analytic apparatus is set in place, I will proceed to explore issues relating to data needs in regard to the occupational affiliation of women. First, I would observe that concern with the occupational attachment of women is largely motivated by the sizeable earnings gap between the sexes. After adjusting for sex differences in average full-time hours worked, women's median earnings in 1971 were only 66% as much as those of men.[7] This implies a sex earnings differential of 52% when using the median earnings of women as the base. According to my own study [Oaxaca, 1977], there is evidence that the gap has actually been widening over a period of at least 20 years.

The average wage for a group of workers at a point in time can be expressed as a weighted average of the average wages in a completely exhaustive and mutually exclusive set of occupations. The weights are the proportions of workers who are in the various occupations. Thus we have

$$\bar{w}_t = n_t' \bar{W}_t \qquad (17)$$

where

$\bar{w}_t$ is the average wage at time t,

n_t' is a row vector of the proportion of workers in each occupation, and

$\bar{W}_t$ is a column vector of the average wage in each occupation.

It is easy to decompose the wage gap between men and women into the male-female difference in occupational distribution and the sex difference in wages within occupation:

$$\Delta w_t = \Delta n_t' \bar{W}_{ft} + n_{ft}' \Delta \bar{W}_t + \Delta n_t' \Delta \bar{W}_t \qquad (18)$$

where

Δw_t is the male-female wage difference at time t $(\bar{w}_{mt} - \bar{w}_{ft})$,

$\Delta n_t'$ is a row vector of the male-female difference in the proportion of workers in each occupation, and

$\Delta \bar{W}_t$ is a column vector of male-female wage differences by occupation.

The first term in (18) indicates how much of the wage difference stems from sex differences in occupational distribution, and the second term indicates how much of the difference is due to sex wage differences within occupations. The last term in (18) is just a second order term of differences that arise because of the discrete nature of the wage decomposition.

For any given occupation, the average wage is obtained by evaluating the occupational wage structure at the values of the effective human capital components averaged across individuals comprising the occupation:

$$\bar{w}_t^0 = \beta_t^{0\prime} \bar{\bar{K}}_t^0 \qquad (19)$$

where

$\bar{w}_t^0$ is the average wage in occupation 0, and

$\bar{\bar{K}}_t^0$ is a column vector of the mean values of the effective human capital components.

It is clear that the male-female wage difference in each occupation can be expressed in terms of sex differences in human capital components and sex differences in market rental values for human capital. Sex differences in market rental values within the same occupation are clearly discriminatory. One might imagine that one of the human capital characteristics considered by employers is the sex of the worker. This component takes on the value one if the worker is male and zero otherwise. Associated with this sex dummy variable is a positive market rental value. This would be sufficient to generate a sex wage bias. More generally, we might posit a sex bias in the entire vector of market rental values.

Empirically, we could estimate separate wage equations for each sex in each occupational category. The differential reward for characteristics such as experience or age could then be estimated. However, sex differences in the estimated coefficients may not be accurate indicators of sex differences in market rental values. This is because a year of experience may represent different skill acquisitions or human capital investments between men and women. Thus even if a male and a female were of the same age or experience cohort, they could still differ in their vector of human capital components. This difference itself may be attributable to differential opportunities for OJT, but now sex bias is more subtle because of the obvious difficulty in directly measuring human capital.

According to the occupational crowding hypothesis [Bergman, 1974], women are confined to a relatively narrow range of occupations which depresses the wages in these occupations for both men and women. In our framework, this means that the market rental rates of human capital are depressed in these occupations. Any observed wage differentials between men and women in these occupations would be mainly the result of differing

skill vectors. Many women in the early stages of the working life would have much higher future wages if they were employed in nontraditional, male dominated occupations. However, as time goes on opportunities for skill enhancement diminish as women remain in the traditional female occupations. There is also the possibility that certain female occupations are close substitutes for higher paying male occupations. In a variant of the shell game, occupational titles are juggled around in order to mask wage discrimination as occupational differentiation.

Estimation of the contribution of different occupational distributions and wage difference within occupations to the overall sex difference in wages is somewhat arbitrary. The level of occupational aggregation will influence estimates of the relative importance of each of the two sources of the sex difference in wages. As an extreme example, if all workers were lumped together in a single occupational category none of the sex wage difference could be attributed to different occupational distributions. At the other extreme, occupational categories could be made to correspond to each job. For some jobs the minimal "skill" requirements may include the restriction that all workers be of the same sex. Under such circumstances, perfect job segregation would dispose of wage differentials within occupations as a source of the overall male-female wage differential. Unavoidably, the level of occupational disaggregation used for data collection purposes is the product of compromise.

Changes in the overall male-female wage difference stem from changes in sex differences in occupational distribution and changes in sex wage differences within occupations. There are any number of ways to summarize these effects over time. One possibility is to adopt the occupational similarity index used by the Council of Economic Advisors [CEA, 1973]. The value of the index at time t (I_t) is computed by

$$I_t = (1/2) \sum_j |\Delta n_{jt}| \qquad (20)$$

where

Δn_{jt} is the difference between the fraction of male workers who are employed in the j^{th} occupation and the fraction of female workers who are employed in the j^{th} occupation.

The value of the index can range from zero (identical occupational distributions) to one (perfect occupational segregation). It might be useful to discover those macroeconomic factors that can explain movements in the index over time. Unfortunately, the level of occupational disaggregation needed to meaningfully detect changes in occupational similarity is readily available only in census years. Annual data on occupational distribution by sex are published only by very broad occupational category. Consequently occupational movements within broad categories can only be detected in census years. Similarly, earnings data by sex by occupation are available on the same basis as occupational distribution data--a great deal of detail in census years but only broad occupational categories in the interim.[8] In addition to more occupational detail on an annual basis, it would be very helpful to have data on average or median occupational wage rates by sex. Earnings of year round-full time workers is a proxy for the wage rate, but there still remain sex differences in the average annual hours of work even among these workers.

While economy-wide occupational data are very useful for assessing general movements in the occupational affiliations of women workers, in and of themselves they do not provide the information needed to implement effective public policy nor do they enable individual women to respond to new occupational opportunities. Information needed for individual choices

as well as for the operation of programs to assist women in finding new occupational opportunities must be available at the level of the local labor market. The importance of this consideration is easily grasped by viewing the same problem in another context. Does a low unemployment rate for the U.S. as a whole signify prosperity for Appalachia? Or to put it another way, should economy-wide expansionary fiscal and monetary policy be adopted in order to lower the unemployment rate in Appalachia? Efficient resource allocation requires that information be available at the local level.

The monthly Current Population Survey (CPS) conducted by the Bureau of the Census cannot be used to obtain occupational data at the level of the local labor market. This is of course because the sample size is only large enough to achieve statistical reliability for nationwide aggregates. Fortunately, detailed occupational data are available at the local labor market level for census years. From census data one can compute detailed occupational distributions across detailed industry categories. These fractions have been incorporated into an industrial-occupational (I-O) employment matrix by the Bureau of Labor Statistics (BLS) for the U.S. as a whole. The I-O matrix is defined over 200 industries and 400 occupations. Many state departments of employment security in cooperation with the BLS have developed similar matrices on a statewide basis and in some instances at the local labor market level.

Forecasts of occupational employment are obtained by applying the I-O matrix to industry employment forecasts obtained from econometric models of the national, state, and local economies. At the present time there is no breakdown by sex. Thus while overall occupational employment can be forecast in a given area, there is no current effort to obtain these forecasts

separately by sex. If the occupational-industry employment distribution from the census were differentiated by sex, the potential number of entries in the I-O matrix would double from 80,000 entries to 160,000. Naturally, there would be many null entries for local areas. And in any event, the availability of computer information retrieval systems makes the task a manageable one.

Unfortunately a problem still remains even if occupational forecasts can be obtained for women at both the national and local levels. The occupational distributions that existed at the time of the census are incorporated into future forecasts. Strictly speaking distributional trends cannot be picked up, let alone seasonal and cyclical movements in occupational distributions. At the present time some of the states, in cooperation with the BLS, update their I-O matrices once during the intercensus period to incorporate perceived trends in the occupational distribution. More frequent updating of the I-O matrix is necessary to improve the accuracy of occupational forecasts as well as to provide researchers with the data needed to understand the process underlying staffing patterns in industry. Obviously a complete national census cannot be conducted any more frequently than every 10 years. Nevertheless, state offices of employment security can and do survey local employers to obtain current information on employment by occupation.

There continues to exist an important need for research on occupational choice and occupational mobility among women. The economist's systematic treatment of occupational choice goes at least as far back as Adam Smith, with refinements continually being made. In recent years there have been studies which examine the link between expected lifetime labor force participation and the occupational affiliation of women [Zellner, 1975] and

[Polachek, 1977a, b]. According to Zellner, those occupations which involve only modest wage growth possibilities but relatively high wages for low experience levels would tend to be more attractive to individuals who anticipate relatively little labor force participation over the lifetime. Occupations which offer ample opportunities for wage growth but which offer relatively low wage possibilities for low experience levels tend to pay off for those contemplating full time labor force participation over the working life. According to Polachek, those who anticipate intermittent labor force participation would tend to be attracted to occupations in which skill depreciation is relatively unimportant. In the absence of exceptionally strong nonpecuniary rewards it simply does not pay to invest in skills which rapidly depreciate during prolonged absences from the labor force if one expects to spend lengthy or frequent spells out of the labor force.

While the above approaches attempt to explain the occupational affiliations of women on the basis of lower expected lifetime labor supply and intermittent labor force participation, they are not meant to imply that discrimination has nothing to do with the occupational choices of women. Labor force participation and occupational choices are the results of constrained utility maximization. Where women are concerned, labor market discrimination or the anticipation of discrimination obviously influence the constraints. In order to better understand the determinants of occupational choice and occupational mobility, we require longitudinal data at the household level. The National Longitudinal Survey of mature women is an example of the type of survey data that is needed. Since theories of human capital formation and occupational mobility are based on life cycle models, it is imperative that socioeconomic data on women over their working lives be made available for research.

IV. Concluding Remarks

In order to ask the right questions about the occupational affiliation of women, it is necessary to have some sort of theoretical frame of reference. Very little is known about the technological conditions governing the formation of skills on the job, and much more needs to be known about occupational choice and mobility. As a small step toward asking the right questions, a simple framework has been presented which links together occupational affiliation, human capital formation, and wage rates. It affords a means of discussing both theoretical and empirical issues that relate to the occupational attachments of women.

Data limitations can be found at both the macroeconomic and microeconomic levels of analysis. For the purposes of understanding and predicting changes in occupational distribution among women, annual data on detailed occupational distributions must be made available. Similarly, detailed occupational data should be made available on a more frequent basis for local labor markets. Public policy aimed at enhancing the occupational opportunities for women cannot be made fully operational merely on the basis of economy wide statistics, nor can individuals really respond effectively to information on U.S. wide averages. Finally, comprehension of how individuals choose occupations and subsequently form marketable skills depends upon the availability of longitudinal data on individual households.

Although many individuals may not directly consult official statistics in deciding upon human capital investments, they do form perceptions of occupational opportunities from a variety of sources which include information disseminated by public agencies. The purpose of the statistics is to

facilitate resource allocation by making information available to the public and policy makers and to enable researchers to better understand the process of occupational choice and earnings generation.

Footnotes

1. Strictly speaking, the vector of market rental values varies across employers for the same occupational category. The differential rental values represent compensating wage differentials attributable to differing work environments. As a practical matter it is simply not feasible to deal with occupational subcategories defined at the firm level. Necessity dictates a great deal of occupational aggregation. Even so, the Dictionary of Occupational Titles (DOT) lists approximately 20,000 entries.
2. The effects of unions on wages can be analyzed in a similar, though not necessarily identical, manner to minimum wage laws.
3. See [Gordon, 1972] and [Doeringer and Piore, 1971].
4. In terms of equation (7), $\Delta K_{it} = Q_{it} - \delta_{it} K_{it} > 0$.
5. It is assumed that β^{0}_{it-1} and $K^{0}_{it-1} \neq 0$. In the event that this condition is not satisfied, the base value for the proportionate change can be easily modified so as to avoid division by zero.
6. See [Heckman, 1976].
7. [Council of Economic Advisors, 1973].
8. For empirical evidence on the roles of occupational distribution and sex differentials within occupations in the overall male/female wage differential see [Oaxaca, 1977].

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